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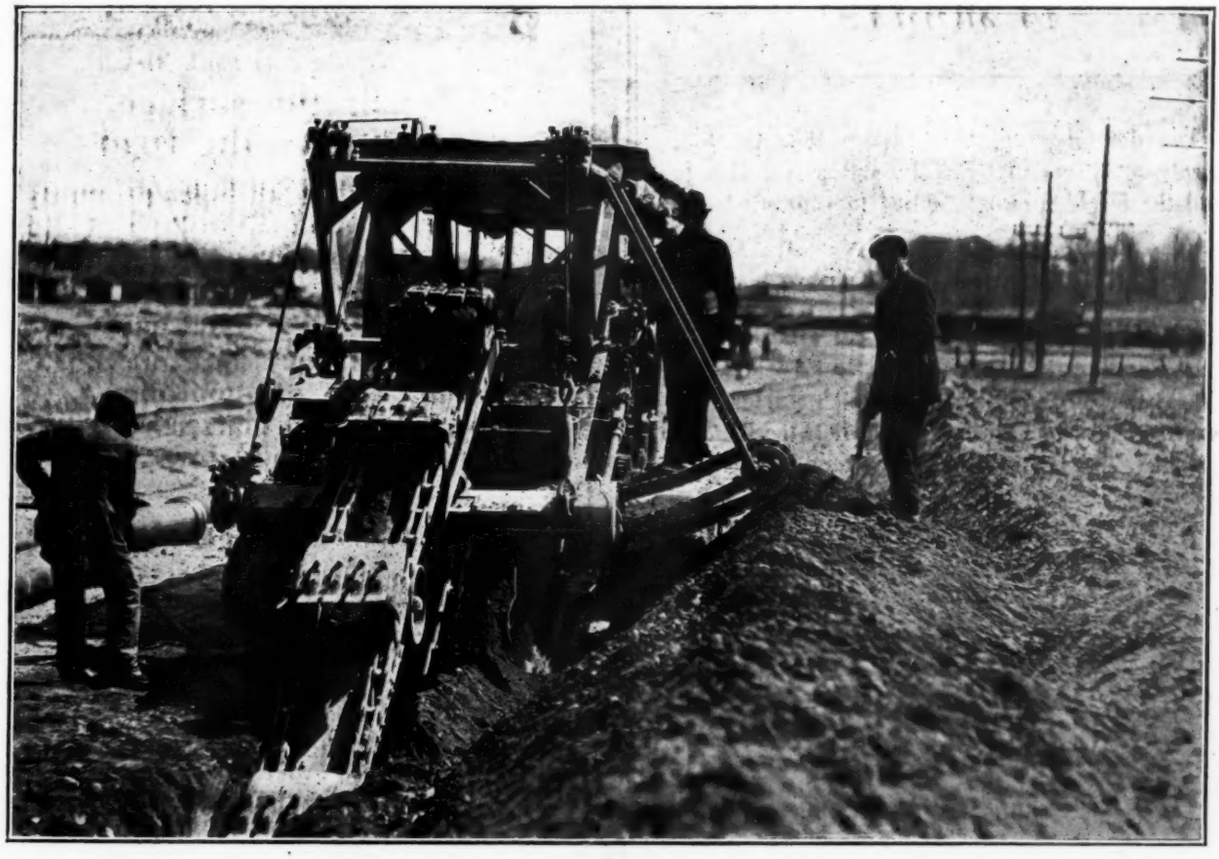

MACHINE EXCAVATION OF WATER PIPE TRENCH BY BALTIMORE WATER DEPARTMENT

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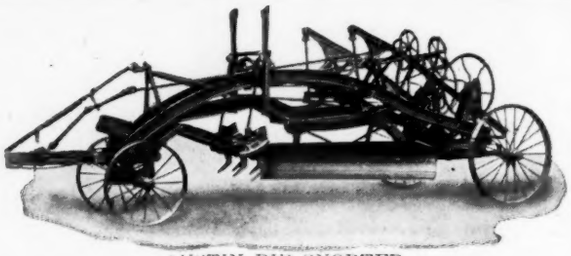

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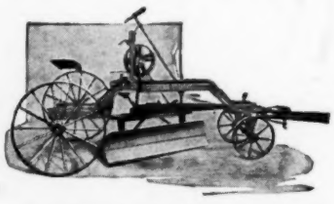

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Vol. 51 JULY 16, 1921 No. 3

Mechanical Equipment of Baltimore Water Department†

By V. Bernard Siems*

Ownership and operation of trench excavators and other mechanical equipment by the Department. Performance and cost records given in great detail and compared with hand labor costs.

Machinery for excavating earth and other material has been recognized for years as more economical and efficient than manual methods where conditions will permit the use of such mechanical equipment.

In order to complete the construction of water supply and sewerage systems in the cantonments during the world war as quickly as possible, the United States Army used machinery entirely, and the results obtained have, no doubt, had a great effect on the increased use of trench excavators, cranes and backfillers by contractors and municipalities. The writer used trenching machines, cranes and backfillers entirely for the construction of the water distribution system for Camp Meade and Camp Franklin in 1918. The distribution system of Camp Franklin and the enlargement of the Camp Meade system were completed in 2½ months. Machinery of all characters was used to construct the intake and pumping stations and enlarge the filtration plant and balancing reservoirs at Camp Meade.

*Associate Civil Engineer, Baltimore Water Department.

†Paper presented at the 41st Annual Convention of the American Water Works Association.

BALTIMORE WATER DEPARTMENT'S BACKFILLER AT WORK

In 1913 the engineers of the Baltimore City Water Department saw the necessity for obtaining a trenching machine, air compressor and pneumatic hammer to execute more expeditiously the work in connection with the installation of water mains. The Highway Department, in 1913, graded 33d street from Greenmount avenue to Hillen road, an approximate distance of 1.1 miles, preparatory to constructing a boulevard. The Water Department started the work of installing a 16-inch middle service water main by hand labor, and as the cost of doing the work was exceeding the estimated amount appropriated, the department engineers rented a trenching machine from the Consolidated Gas Company, and with the use of this machine the work was rapidly pushed to completion and the cost was less than the amount actually appropriated. This rented machine excavated 2,000 linear feet of trench, and the final cost showed that the excavating had been done at 16 cents a cubic yard. Based on this excellent showing, the Water Department was permitted to purchase a Parsons trench excavator, Model "K." Another important reason for permitting the purchase of a trenching machine was that the greater part of future water main installations would be in the northeastern and northwestern sections of the city where few, if any, subsurface structures would be encountered, and conditions would be ideal for operating trenching machines. The normal corps of fifteen laborers was too small to permit constant operation of the trenching machine in the work of laying water mains and backfilling, and it was necessary to increase the number of men. In order to still increase the amount of work and bring the water mains construction corps to the normal size of fifteen laborers, air compressors and pneumatic hammers were procured. This latter equipment was also necessary to secure uniform caulking of all pipe joints and thereby decrease the probability of leaks occurring after the laying of improved paving; it also reduced the time, and consequently the cost of labor, in caulking.

The first air compressor purchased was of Foster & Hosler make and had a capacity of approximately 80 cubic feet. Considerable difficulty was experienced in training the caulkers to use the pneumatic hammers intelligently in order to prevent breaking the bells of cast iron pipe. Tests conducted over a long period showed that pneumatic hammers should operate under a long stroke and at a moderate working pressure of 40 pounds per square inch.

The Engineering and Construction Division of the Water Department now has the following equipment.

Equipment	Original Cost
4 Air compressors (ranging from 80 to 210 cubic feet capacity)	$ 8,189
2 Backfillers	3,488
1 Austin 5-ton crane	8,095
1 Ransome concrete mixer	802
1 Air piling hammer	275
10 Ditch pumps	3,447
3 Trenching machines	23,794
Total	$48,090

From the accompanying table it is particularly noticeable that most of the machinery was purchased by the Water Department between the years 1918 and 1920. This table also shows the total equipment of the larger types of machinery now used by the Water Department.

TRENCHING BY MACHINE

Since the year 1914 the Water Department has used trenching machines under almost all conditions in the installation of water mains in public highways. The Parsons Model "K" trenching machine was put to a severe test at one time in excavating for the installation of a 4-inch water main in a private alley between ten and twelve feet in width. Difficulty was experienced in getting a trenching machine of this size in the alley, and damage was done to the wooden fences on each side of the alley. But even considering the difficulties and the expense entailed because of the damage done, the cost of installing the 4-inch main was much less than it would have been if done by manual labor. It may be interesting to note that a comparison of the cost of doing work in private alleys of various width and public highways, whether done by manual labor or by trenching machine aided by hand labor, shows

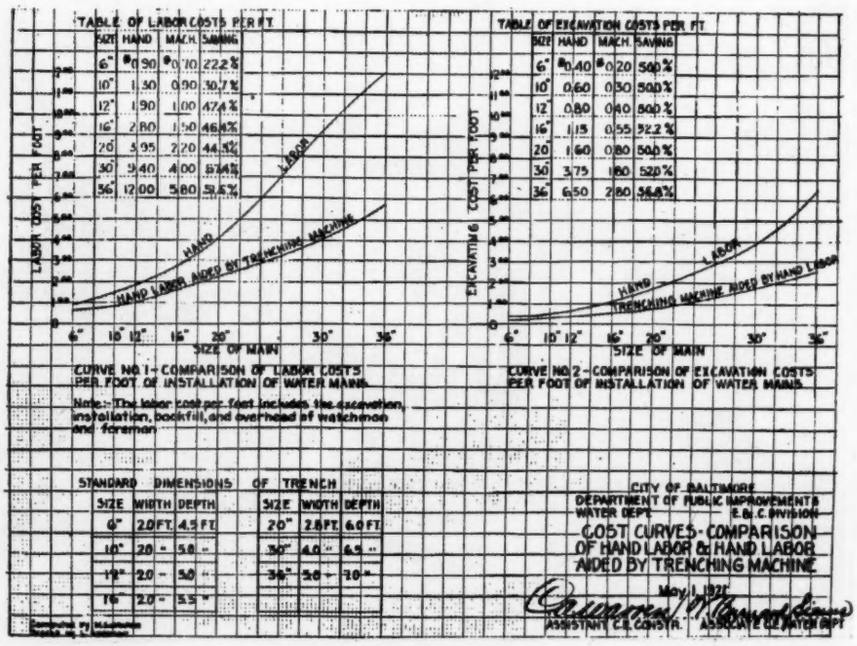
TABLE OF LABOR COSTS PER FT
SIZE HAND MACH. SAVING
6" $0.90 $0.70 22.2%
10" 1.30 0.90 30.7%
12" 1.90 1.00 47.4%
16" 2.80 1.50 46.4%
20" 3.95 2.20 44.3%
30" 5.40 4.00 25.4%
36" 12.00 5.80 51.6%
LABOR COST PER FOOT
SIZE OF MAIN
LABOR
HAND
HAND LABOR AIDED BY TRENCHING MACHINE
CURVE NO. 1 - COMPARISON OF LABOR COSTS PER FOOT OF INSTALLATION OF WATER MAINS
Note:- The labor cost per foot includes the excavation, installation, backfill, and overhead of watchmen and foreman
TABLE OF EXCAVATION COSTS PER FT
SIZE HAND MACH. SAVING
6" $0.40 $0.20 50.0%
10" 0.60 0.30 50.0%
12" 0.80 0.40 50.0%
16" 1.15 0.55 52.2%
20" 1.60 0.80 50.0%
30" 3.75 1.80 52.0%
36" 6.50 2.80 56.8%
EXCAVATING COST PER FOOT
SIZE OF MAIN
LABOR
HAND
TRENCHING MACHINE AIDED BY HAND LABOR
CURVE NO. 2 - COMPARISON OF EXCAVATION COSTS PER FOOT OF INSTALLATION OF WATER MAINS
STANDARD DIMENSIONS OF TRENCH
SIZE WIDTH DEPTH
6" 2.0 FT. 4.5 FT.
10" 2.0 " 5.0 "
12" 2.0 " 5.0 "
16" 2.0 " 5.5 "
20" 2.5 FT. 6.0 FT.
30" 4.0 " 6.5 "
36" 5.0 " 7.0 "
CITY OF BALTIMORE
DEPARTMENT OF PUBLIC IMPROVEMENTS
WATER DEPT. E. & C. DIVISION
COST CURVES - COMPARISON OF HAND LABOR & HAND LABOR AIDED BY TRENCHING MACHINE
May 1, 1921
ASSISTANT C.E. CONSTR.
ASSOCIATE C.E. WATER DEPT.

FIG. 2.—INSTALLATION COST CURVES—HAND LABOR VS. HAND LABOR AIDED BY TRENCHING MACHINE

Table No .1
Method of Ascertaining the Cost per Hour of Operating Machines

Type of machine	Designated as	Original cost	Probable life	Date of delivery	Probable No. of hours in operation per year	Depreciation cost per hour	Fuel consumed cost per hour	Probable repair per hour	Total cost per hour	Operator's cost per hour	Total operat'g cost per hour
Air Compressors:											
Ingersoll-Rand	A.C.1	$3,058	5 years	Nov., '20	2,000	$0.31	$0.61	$0.08	$1.00	$1.00	$2.00
Sullivan	A.C.2	2,531	5 years	Dec., '20	2,000	0.25	0.61	0.09	.95	1.00	1.95
2 Foster & Hosler	A.C.3&4	1,300	5 years	Mar., '18	2,000	0.13	0.15	0.02	.30	1.00	1.30
Backfillers:											
Backfiller M.5	B.1	847	5 years	Oct., '18	800	0.21	0.11	0.10	.42	1.00	1.42
Backfiller M.10	B.2	2,641	5 years	Oct., '20	800	0.66	0.37	0.10	1.13	1.00	2.13
Crane:											
Austin	C.1	8,095	5 years	Aug., '19	1,000	1.62	0.96	0.20	2.78	1.00	3.78
Concrete Mixer:											
Ransome	C.M.1	802	5 years	Oct., '20	800	1.00	0.23	0.02	1.25	1.00	2.25
Hammer:											
Air Piling	A.H.1	275	5 years	Mar., '20	250	0.22		0.03	.25	1.00	1.25
Pumps:											
3-No. 00 4 h.p.	P.1	390	3 years	Mar., '19	2,000	0.07	0.19	0.04	.30	1.00	1.30
3-No. 00 2½ h.p.	P.2	349	3 years	Apr., '19	2.000	0.06	0.19	0.04	.29	1.00	1.29
1-No. 00 Centrif.	P.3	490	3 years	Feb., '19	2,000	0.08	0.19	0.04	.31	1.00	1.31
1-Domestic	P.4	180	3 years	Feb., '19	2,000	0.03	0.19	0.03	.25	1.00	1.25
1-Schramm	P.5	280	3 years	Feb., '19	2,000	0.05	0.19	0.04	.28	1.00	1.28
Trenching Machines:											
Parsons Model K	T.M.1	5,542	5 years	Apr., '14	1 456		1.39	0.31	1.70	1.00	2.70
Parsons Model 24	T.M.2	8.052	5 years	Dec., '20	1,456	1.12	0.63	0.25	2.00	1.00	3.00
Parsons Model 36	T.M.3	10,200	5 years	Apr., '20	1.456	1.40	1.39	0.25	3.04	1.00	4.04

Columns Nos. 1, 2, 3, 4, 5, 6, 10, 11 and 12 are self-explanatory. Column No. 7—Column No. 3 divided by column No. 4, equals depreciation cost per year, and this quotient divided by column No. 6 equals depreciation cost per hour. Column No. 8—Fuel consumed per hour was ascertained by test on each machine and is approximately as follows: 90 per cent gasoline, 3 per cent grease and 7 per cent lubricating oil. Column No. 9—Yearly cost of repairs for each machine divided by column No. 6 equals repair cost per hour.

that the cost of the installation in private alleys is twice that of the cost in public highways. The Water Department, therefore, does not even consider the installation of water mains in private alleys. Judging from our records of cost, such installations should be discouraged by all municipalities.

Trenching machines have also been used to remove the cover of all sized water mains where it has been found necessary to enlarge or replace them by other mains, particularly so in cases where it is necessary to lower the water mains because of a change in the grade of the public highway.

In the residential and business districts where it would be economical to excavate trenches with trenching machine for installation of water mains, accurate locations were obtained of water supply, gas supply and other services in advance of the work. The locations of these services were marked on the curb line, and the trenching machine operator very seldom disturbed any of them as he raised the boom of the machine as it approached these marks. It was, of course, necessary to do the extra excavating around the service pipes by hand labor. In other instances the Department has found it economical to disconnect these services temporarily, in order to provide clearance for the operation of the trenching machine. Even with these additional costs, there was considerable economy in the use of the trenching machine, especially on the installation of large water mains. From our cost data records it is estimated that damages to subsurface structures by the use of trenching machines approximate 1 per cent of the total cost of the installation of the water mains.

OTHER MACHINERY

In 1918, due to the increasing number of extensions of water mains, the scarcity of labor and the high rate of pay necessary because of the salaries paid labor by industrial plants in and around Baltimore, it was decided to purchase additional trenching machines, a 5-ton Austin crane and backfillers. The cost of installing water mains was materially lessened by the use of this machinery in the years 1919 and 1920. The 5-ton crane saved us considerable money, as we handled practically all cast iron water pipe and fittings of 20 inches and over with it. Two types of backfillers are used—one the boom drag and the other the scraper drag. The boom drag is used on the backfilling of trenches for large mains and the scraper drag on smaller mains in territories where the Highway Department will permit backfilling of ditches by puddling the material. We have, however, also used it in public highways where ramming was necessary. Tests made with me-

CRANE HANDLING LARGE SPECIAL CASTING

chanical tampers have not shown satisfactory results thus far. It is hoped that they will be developed to the extent of the other machinery now used by the Water Department. We have a much larger equipment of machinery than that noted in table No. 1 in machines of a smaller character which we purchased from time to time and which are not shown on the table. I believe that the Water Department of the city of Baltimore ranks first among the American municipalities in the use of machinery for doing the work in connection with the installation and maintenance of a water distribution system.

ORGANIZATION FOR OPERATING AND REPAIRING EQUIPMENT

The operating and repairing corps of the mechanical equipment used by the Construction Subdivision of the Engineering and Construction Division is organized as follows: The associate civil engineer of the Water Department is in charge of the division, and under him is the assistant civil engineer in charge of the construction subdivision and the automobile repair man in charge of mechanical equipment. The repair corps is divided into five units, each containing an automobile repair man who receives $.66 an hour, and a handy man who receives $.50 an hour on three of the units and $.45 an hour on the other two. The first unit has charge of backfillers Nos. 1 and 2 and trenching machine No. 1; the second unit has charge of air compressors Nos. 1 and 2 and trenching machine No. 2; the third unit has charge of air compressors Nos. 3 and 4 and trenching machine No. 3; the fourth unit has charge of gasoline pumps Nos. 1 to 6, inclusive and crane No. 1; and the fifth has charge of gasoline pumps Nos. 7 to 10, inclusive, and concrete mixer No. 1. The automobile repairman, grade No. 1, in charge of mechanical equipment, reports directly to the assistant civil engineer in charge of the construction subdivision or his assistant, the same as the water pipe construction foremen do; the five automobile repairmen, grades Nos. 2 and 3, are subordinates, being assisted by handymen, and to each group is assigned equipment which they operate and maintain.

The City Service Commission of Baltimore requires that an automobile repairman must have an elementary education, several years' experience in assembling or repairing and operating gas engines and other mechanical equipment. For handyman it requires an elementary education, one year's experience as general handyman in a machine shop and ability to follow instructions from an automobile repairman. The handymen are also used for burning out lead in cast iron pipe bells on mains of the larger size. From experience it has been found that the best men available for positions of automobile repairmen are those advanced from the position of handyman.

Experience in the use of mechanical equipment has proved to us that it is more economical and efficient to have a storage of duplicate mechanical parts available for any emergency than to order the repair parts when needed. The automobile repairman, grade No. 1, in charge of mechanical equipment is held responsible for stock parts of mechanical equipment, and also for repairs to machinery. After the completion of the work the machinery is inspected thoroughly before being transported to another location, and, therefore, it is always in good working condition to commence the next work.

(*To Be Continued*)

Boston's Refuse Disposal Specifications

Principal features of specifications on which Boston expects to let contract in a few weeks. Removal and disposal by alternative methods.

Last week we gave in abstract the principal features of a form of contract upon which the city of Boston is inviting bids for disposing of its refuse. In the following paragraphs will be given the more important features of the specifications accompanying said contract.

In both contract and specifications the word "refuse" has been used where we think better practice would use the word "rubbish," "refuse" being generally applied so as to include all kinds of waste material including both garbage and rubbish. However, the word has been used herein as in the Boston specifications to include only refuse materials other than garbage.

The contractor is required to dispose of all garbage and refuse delivered to him by either the city or a contractor hauling material for the city, and also of "all garbage and refuse delivered to him by the producers or private collectors at any collection station, provided he is paid by such producers or private collectors for such disposal at a rate not exceeding five cents per barrel of four cubic feet."

The city contemplates continuing the present practice of having garbage placed in one receptacle and all other household wastes in another; except that in portions of four of the districts a third separation is made of paper, wooden and paper boxes, excelsior and other light materials. The city will secure as complete a separation of materiasls as it may find to be practical, but any failure on the part of householders or others to separate the materials will not be held to justify the contractor's default in fulfilling any of the requirements of the contract.

Garbage and refuse will be delivered at several stations whose locations are specified. "No putrescible material shall be allowed to remain in the stations beyond 7 o'clock a. m. of the day succeeding its delivery, and all garbage and refuse shall be removed from the stations as soon as possible. In no case shall the stations be used for storage of saleable material by the contractor, nor shall such material be allowed to collect so as to interfere with the operation of the city vehicles . . . No sorting of garbage or refuse or any operation of final disposal shall be conducted at any receiving station."

For removing material from wharf stations the contractor must use scows of a design satisfactory to the commissioner. "The loads shall be so enclosed and protected as to prevent the escape of disagreeable odors during transit and the dropping of any portion of the loads into the waters of Boston harbor. The contractor shall at all hours during the day and night prescribed by the commissioner keep at each wharf station at least one scow, so placed and of such capacity that all garbage and refuse brought thereto can easily and immediately be placed thereon."

As a matter of information for the contractor, the specifications contain a table giving approximate weights of garbage and refuse collected within the proposed contract area for the year ending January 31, 1921. This is not assumed to be complete, but is given merely to enable the contractor to judge somewhat of the character and amount of garbage and refuse.

Approximate weights (tons of 2,000 pounds) of garbage and refuse collected within proposed contract area, year ending January 31, 1921, distributed among proposed districts.

District	Estimated Population	Garbage	Ashes and Rubbish	Street Sweepings
1. South Boston	70,400	4,400	25,000	9,700
2. Charlestown	34,600	1,800	.....	.....
3. North and West Ends	72,200	4,400	51,000	15,300
4. South End & Back Bay	113,700	13,100	73,000	16,700
5. Roxbury and Jamaica Plain	150,400	10,400	56,000	17,100
6. Dorchester	156,400	15,200	.....	.....
Totals	597,700	49,300	205,000	58,800

FINAL DISPOSAL

If the contractor so desires, the city will furnish him free of cost the land which it owns on Spectacle island, together with wharves, buildings, etc., which will become its property on the expiration of the existing contract.

Methods of Disposal.—Bids may be based on any of the following methods for the final disposal of garbage and refuse, or on combinations of the same:

For Garbage: (*a.*) By incineration. (*b.*) By reduction. (*c.*) By any other method or combination of methods satisfactory to the Commissioner.

For Refuse: (*a.*) By incineration. (*b.*) By filling of marsh lands or flats along the waterfront, or on islands in the harbor, when properly bulkheaded to prevent the escape of rubbish. Clean ashes or any material whose specific gravity is greater than salt water may be disposed of by dumping at sea or by filling. Rubbish may be disposed of by filling, or by salvaging the marketable material and disposing of residue by incineration or for filling.

Incineration of Garbage and Refuse

If incineration of the garbage and refuse be adopted, in whole or in part, the process shall be subject to the following conditions:

(*a.*) *Destructors.*—The Contractor shall erect, maintain and operate destructors of sufficient capacity to handle daily 50 per cent more garbage and refuse than is shown by the average daily collection for the past year. He shall determine the capacity required and submit with his proposal complete detailed specifications for the plants.

(*b.*) *Destructor Capacity.*—The destructor capacity shall be determined upon the basis of a specified mixture of garbage and refuse to be stated by the Contractor in his proposal.

It is to be understood that the specified mixture is simply to establish a basis for making the tests and in no way lessens the Contractor's responsibility to provide a complete plant of sufficient capacity to handle the garbage and refuse as delivered to him under the varying conditions pertaining to the different seasons of the year.

(*c.*) *Tests.*—The guaranteed capacity must be developed, before acceptance, by four tests of at least eight hours each. When making the test the furnaces are to be brought to the normal working conditions before starting, and on ending, the pressure temperatures and furnace conditions are to be brought to the same conditions as when starting. The destructor plant is to be equipped with suitable thermometers and pyrometers for recording the temperatures in the combustion chambers, boiler uptakes, chimney, air supply, etc. Apparatus for analyzing the chimney gases is also to be provided. All expenses of the test shall be borne by the Contractor. Under ordinary running conditions, either when testing or at other times, no auxiliary fuel is to be used in the destructors. Thermometers and pyrometers for recording temperatures and appliances for analyzing the chimney gases shall be provided by the Contractor at any time on request of the Commissioner.

(*d.*) *Ventilation.*—A positive system of ventilation must be provided, so that the forced draft for the destructor furnaces shall be taken from the vicinity of the storage bins and other places needing ventilation and prevent the escape of unpleasant odors. The design of the destructors must provide settling chambers of such size that the velocity of the gases will be adequately reduced and the dust deposited so as not to escape from the chimney. At no time during the continuous operation of the plant shall the minimum temperature in the combustion chamber be less than 1,250 degrees, and the average must be at least 1,600 degrees Fahrenheit.

(*e.*) *Cleaning.*—Ample room must be provided for the cleaning of all flues, dust-settling chambers, boiler tubes, etc., so that the plants may be operated continuously six days each week, one day (Sunday) being allowed for cleaning. The dust chambers, flues, etc., shall be so arranged as to allow of dust being withdrawn after one day's cooling.

Incineration of Rubbish

If the Contractor proposes to submit any portion of the refuse to a sorting process, and so arrange his reclamation plant that the residue from such process is to be incinerated, for such a purpose each incineration unit shall not only be of ample furnace capacity, but shall have a large combustion chamber and liberal size and height of stack to produce the required draft; combustion chamber and stack shall be so proportioned as to elimate smoke and disagreeable odors. If the waste heat of such incinerator is utilized for raising steam in attached boilers, a suitable by-pass duct shall be provided so that the boiler may be cut out for repairs.

Reduction

(*a.*) *Location.*—The Contractor may establish a plant for the reduction of garbage in a location satisfactory to the Commissioner and the health authorities having jurisdiction over the proposed location, but such location shall not be upon the mainland within the city limits; or he may utilize the land, wharves, buildings, etc., at Spectacle Island as soon after the completion of the Boston Development and Sanitary Company's contract on July 1, 1922, as said company may require for the removal of its machinery, etc., from the city's property.

(*b.*) *Construction.*—The Contractor shall provide for the operation of his reduction process a fireproof building of brick, stone or concrete, or a combination of the same, of a design satisfactory to the Commissioner and architecturally in harmony with its surroundings. The structure shall be of ample size for the processes and so designed as to admit of extension in all departments.

(*c.*) *Ventilation.*—The buildings shall be so constructed as to prevent, as far as possible, the escape of disagreeable odors. The arrangement of conveyors, tanks, presses, etc., shall be such that after the delivery of the garbage to the conveyor at the wharf the process shall be continuous and the apparatus so inclosed that the material shall be at no time exposed to the outside air. The process, machinery and appliances shall be thoroughly sanitary in effect, and the plant so conducted as not to cause conditions which would be detrimental to the public health or in any way constitute a nuisance.

All gases carrying odors which are produced or result from the operation of the process, machinery or equipment used shall be confined, and, before being discharged into the air, shall be thoroughly deodorized.

All water flowing from the plant shall be inoffensive, free from nuisance or any matter dangerous to the public health.

(*d.*) *Poisonous or Explosive Material.*—If the Contractor shall use in any part of his process any volatile, poison-

ous or explosive material, such portion of the process shall be conducted in a fireproof apartment entirely separated from the remainder of the plant.

Where material is to be dumped, "suitable precautions shall be taken to protect neighboring premises from flying paper, dust, damage from smoke and from all danger of fire on account of such dumps." No garbage or refuse containing garbage will be permitted to be dumped.

Clean ashes and any material whose specific gravity is greater than salt water can be disposed of by dumping at sea in such locations as the commissioner may designate and under such regulations as may be imposed by the United States harbor authorities. Paper, garbage or other floating material must not be dumped except in cases of extreme emergency, such as fire, flood or extraordinary ice in the water surrounding the city or in the harbor.

If the contractor, from any cause except these just named or for other extraordinary and unavoidable causes, shall fail for more than five successive days to dispose of the garbage and refuse as specified by the contract, the commissioner may cancel the contract or may take possession of the property and operate it for disposing of the garbage and refuse, any excess of cost of such disposal by the city over the contract price being repaid to the city by the contractor; or, if the city does not elect to do either of these, "the contractor shall forfeit and pay the city, as expenses, losses and damages incurred by the city through the contractor failing to do work as aforesaid, a reasonable proportion of the payment for the work for the month in which such failure occurs, as determined by the commissioner."

In performing all of these services the contractor must protect the employees from all avoidable danger of life, limb and health, and contribute to their comfort and well-being. He shall provide facilities necessary for their cleanliness, including an adequate supply of hot and cold running water. For workmen engaged in specially dirty work there shall be facilities for bathing with running hot and cold water and for washing and drying clothing.

Municipal Street Cleaning for Philadelphia

As described in Public Works some weeks ago, the city of Philadelphia is trying out municipal street cleaning in one district, but let contracts for cleaning the streets in the remaining parts of the city. The success of the municipal cleaning has apparently been so pronounced that it has been decided to commence on January 1, next, the municipal cleaning of all the city's streets.

The street cleaning contracts let for this year provided that these contracts could be terminated on October 1 of this year if three months' prior notice was given. The administration wished to give such notice and begin city-wide street cleaning by municipal forces on October 1, but could not obtain the necessary permission and appropriation from council, which, however, has promised to support a full program of municipal work after the contracts expire on December 31.

Operation and Care of Concrete Mixers

Starting and care of boiler and engine. Securing maximum yardage. Keeping mixer clean. Shutting down for the winter.

Instructions for concrete paving mixers that are in general applicable to construction mixers have been issued by the Koehring Company and excerpts from them are here presented for their value in clearly describing important items in the maintenance of all kinds of mixers, their boilers and engines:

PREPARING TO START MIXER

After mixer is assembled, see that all grease and oil cups are full, using a good grade of oil and No. 3 cup grease. Grease cups should be screwed down at least twice a day, to keep all the bearings well lubricated. Be sure to keep all cables lubricated with good cable compound, and all gear teeth well lubricated with a good graphite grease, but DO NOT put grease on rollers or drum runway. The cable clamps should all be gone over to make sure all nuts are tight, as a loose clamp may cause trouble.

Before starting the engine, be sure that all clutches are disengaged; by so doing a bad accident may be avoided.

STARTING AND CARE OF BOILER

After mixer is assembled, a slow fire should be started in the boiler. Do not crowd the fire until steam pressure shows on the gauge, indicating that sufficient steam has been generated to protect the top ends of the tubes; which, in full-length tube boilers are exposed to the hot gases. Hard firing in getting up steam is almost certain to damage the top ends of the tubes. This not only applies to firing the boiler the first time, but holds good for every time a new fire is made.

During the first day's operation, do not keep the water level in the boiler above the middle of the gauge glass, as the water will, undoubtedly, foam on account of the oil and grease on the plates. Blow down the water glass several times a day but never depend on it, as the opening may become choked keeping the water level apparently constant, while the water in the boiler may actually be getting very low. The water cocks are put in the boiler to use, and are the only sure way of ascertaining the water level.

The boiler should be blown off well at the end of the day to remove all grease. After this, sufficient water should be carried in the boiler to show ¾ of the way up on the gauge glass.

Keep a thin clean fire. This will give you 100% more heat than a thick dirty fire, as the smoke from a thick fire chokes up the tubes, and combustion takes place not in the tubes but in the hood and stack. Clinkers should be removed from the fire box frequently and the ash box should be kept clean. Doing so prolongs the life of the grates and gives a better draft.

If at any time the boiler is to remain out of use for a few days, place a cover over the smoke stack to prevent water rusting out the tubes.

There will probably be injector trouble the first day, due to clogging from scales from new pipes and boiler. In such an event, take injector apart and clean thoroughly.

The boiler tubes should be kept clean, as the soot collected on them is a nonconductor of heat and more fuel is required in order to keep up steam. As often as is necessary, the tubes should be cleaned with a scraper—the frequency will depend entirely upon the fuel used and the carefulness exercised in firing, but they should be cleaned in the morning, at least, before firing up, and during the day they should be blown out every once in a while with steam.

Practically all feed waters contain more or less scale forming substance which precipitate and form incrustations in the water leg, on the flue sheet and around the lower end of the tubes.

Frequently the contractor has to make use of muddy water, and this also collects in the water leg and on the lower flue sheet. This scale and mud, if not removed by frequent cleansing, will become firmly baked on the heating surfaces, retarding the flow of the heat to the water and weakening the iron from stresses due to unequal expansion. An accumulation of scale 1/32 inch thick requires 10 per cent more fuel; 1/16 inch of scale requires 20 per cent more; ⅛ inch of scale requires 30 per cent more; and ¼ inch requires 60 per cent more. By keeping boilers clean, considerable fuel is saved.

Under usual conditions the boiler should be blown off a little every day. It is a good plan, before stopping after a day's run, to pump in more water than required while running. The next morning after firing is started and some ten to thirty pounds pressure has been raised, open the blow-off valve and blow the water down to the proper level. If the water is very muddy, it is a good plan to repeat this at the noon hour. After the boiler has been run for some length of time the boiler should be blown down entirely and thoroughly washed. This should be done at least once a week, and in case of muddy water it could be done to advantage twice a week.

The boiler should not be blown down for washing while under steam pressure. The best time to do it is when the steam pressure has just gone down, but the water is still hot. Open the blow-off valve, let all the water run out, remove the handhole plates and wash out the boiler with a hose. To properly do this it is necessary that the water be under pressure and that a properly shaped nozzle is used. A good nozzle can be made of ⅜ inch or ½ inch pipe having a short bend at the end so as to throw the stream of water at right angles to its length and at high velocity. If ½ inch pipe is used, the opening at the end of the pipe should be drawn down a little on a taper so as to give about a ⅜ inch opening.

The boiler should also be scraped with a scraper consisting of an elliptically shaped piece of iron, which would fit the side of the boiler, and fastened to a rod for handle. A very good cleaner can also be improvised from a heavy wire with a piece of chain secured to the end of it.

If the feed water contains ingredients such as to form a hard scale, impossible to remove by washing, a boiler compound may be used to advantage so as to reduce the scale to a muddy consistency that can be washed out.

The best water obtainable should always be used for the boiler. Where necessary to take it from a road side sump, it is well to make two sumps and use one as a settling basin; or barrels may be filled and water drawn from them after the sediment has settled to the bottom.

STARTING AND CARE OF STEAM ENGINE

After all grease and oil cups and lubricator are filled, see that they are feeding properly. The oil cup on the connecting rod when full should last five hours; the lubricator should be adjusted to feed six drops per minute. The engine being oiled and enough steam in the boiler, see that throttle valve is closed and drain cocks in cylinder and steam chest are open. Open valve in steam line near boiler, and the throttle valve just enough to blow out the water in steam line, steam chest and cylinder. After allowing the steam to pass through a few minutes, turn fly wheel off dead center, open throttle slowly until the engine starts running; then close drain cocks and open throttle valve wide. To avoid blowing out of gaskets, the nuts on the studs, holding cylinder head and steam chest cover in place, should be tested and tightened up, if necessary.

When starting an engine in cold weather, limber it up by letting it run idle a little while before placing any load upon it. When engine is started run it slowly, having all cocks open. Many cylinders are cracked by a sudden change in temperature.

In cold freezing weather, drain all water and oil from the cylinder and lubricator when engine is shut down for the night.

MIXER ON WORK

After mixer has been taken to the work, we suggest putting one or more wheelbarrows full of stone in the drum and running the mixer for half an hour or more, thus scouring it thoroughly and removing all roughness. The revolutions of the drum should be tried out.

It is advisable, upon starting a new mixer, to use one-half the normal crew the first day, in order to allow the operator to become acquainted with his machine and to make minor adjustments of the clutches.

After running the machine a couple of days, remove all slack from cables, as new cables stretch with use. This eliminates the jerks by which they are sometimes broken.

After running a week or so, all nuts should be drawn up, as the new bolts may stretch, leaving the nuts loose.

OPERATING MIXER TO INSURE MAXIMUM YARDAGE

The operator should throw in the hoisting clutch, then when the skip has reached the elevation where it is ready to charge drum, start the water flowing from the measuring tank. After skip has been lowered the operator should close the three-way valve when the water stops flowing. He can tell this by watching the gauge glass on the water tank. When concrete has been mixed the required length

of time, has been dumped, and three-fourths of the concrete is out of the drum, the skip should be started up again. By the time it has reached the charging position the drum is empty. Then reverse the tilting discharge chute so that it can aid in mixing the next batch. The operator will have time to run bucket out on the boom and dump it while the batch is being mixed and the skip is being loaded.

KEEP MIXER CLEAN

When contractors finish concreting at noon and in the afternoon, it is advisable to put a few wheelbarrows of stone in the drum and scour it for a few minutes. By doing this a clean drum is assured at all times.

To help instill in the minds of the crew, pride in their work and to secure a maximum of output, the machine should be kept as clean as possible, both on the inside and on the outside. The outside may be kept clean by brushing off the machine each night before shutting down and coating the drum and other parts with oil, which will prevent the cement from sticking. The oil drained from the crank case can be saved and used for this purpose.

In coating the drum and other parts of mixer with oil, care must be taken that no oil gets on the runways of either the drum or the boom.

PREVENT CONCRETE CLOGGING ON BLADES

Cement should never be put in skip first, as it retards the flow of the material when skip is elevated, thereby making it necessary to hold it in that position for a longer time to clean itself. As the cement is last to leave the skip, some of it will stay in the sub-chute until pushed into the drum by the next batch, and some will pack on the inside of the drum head on the charging side, building up a ring around the drum opening. There should always be at least ¼ of the stone or gravel in skip before cement is dumped, as this will aid the flow of material and also prevent the cement hanging in the sub-chute.

It is very important that the water be admitted at the proper time; that is, when the material starts to roll into the drum, so the material and water will enter the drum at the same time to avoid clogging This also increases the mixing efficiency.

SHUTTING DOWN MIXER FOR WINTER

Drain all water from the boiler and steam engine or gasoline engine, and also from piping and water tanks. Pour about one gallon of cylinder oil into the boiler and a quart of oil into the tanks. Fill again with water, then drain. It would be well to add a little whitelead to the cylinder oil just enough to give it a little body.

If mixer is equipped with steam power, remove hood from boiler and clean the tubes out thoroughly with a wire brush and swab carefully with oiled waste or rags. Cover the top of the boiler with canvas and tie it down securely, then coat inside of fire box with heavy oil, and paint or oil the outside of the boiler.

Whether gasoline or steam engine is used, take off cylinder head and coat inside of cylinder with whitelead and oil.

All hard working machinery, especially concrete machinery, must wear; therefore, examine the entire machine carefully and try out all working parts and replace with new parts, those parts, if any, which are worn enough so as not to work properly.

By over-hauling the mixer and replacing all worn parts, when mixer is shut down, no delay will be occasioned by having to make repairs when ready to re-start the mixer in the spring. This should not be neglected, for worn machinery decreases results, and increases delays and consequently labor, and possibly will necessitate extra hours at night for the operator "when the mosquitoes are biting at their best."

After machine has been thoroughly inspected and overhauled, coat all bright parts on mixer with heavy machine oil or, preferably, cylinder oil containing a good heavy body of whitelead. Give balance of mixer a good coat of paint.

Grease all bearings carefully and turn machinery over a few times to insure that the inside of bearings are thoroughly coated. Take off cables and clean thoroughly with kerosene, then pass through a bath of warm lubricant. The following makes a good mixture:

One part freshly slacked lime.
Four parts pine or coal tar.
One-half part powdered graphite.
Heat up and thoroughly mix together.

Clean traction chain thoroughly with kerosene, then give it a good coat of heavy oil.

If possible, house the mixer or cover it with tarpaulin in order to protect it from the weather.

When starting up again after a prolonged shut down, it will, of course, be necessary to clean off all surplus grease and then follow the same procedure as used in starting of a new machine.

ORDERING PARTS

When ordering new parts for a mixer, the contractor should be sure to give the size and number of his machine. This he will find on the nameplate attached to the frame. The part and pattern number he will find in the repair part book which accompanies each mixer.

Enormous Public Construction Due

According to estimates of the Associated General Contractors, normal building construction at present costs would require for manufacturing $306,000,000; residences, $1,195,000,000; business and public works, $396,000,000; public utilities, $492,000,000; miscellaneous building, $303,000,000; railways, $328,000,000; a total of $3,020,000,000 annually.

This is exclusive of highway construction, irrigation, hydro-electric work, river and harbor work.

In addition to the annual normal construction requirements, there is an accumulated construction deficit at present which amounts to almost $15,000,000,000, as follows: Housing, $5,000,-,000,000, railways, $5,000,000,000; public utilities, $1,900,000,000; highways, $2,100,000,000; miscellaneous construction, $500,000,000.

Eliminating housing and buildings, this leaves a present requirement for almost $14,000,000,000 of construction in the public works field, much of it so urgent that it is difficult to see how it can be long delayed even under the present uncertain conditions that are, however, now steadily improving.

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Mechanical Equipment for Municipal Work

Does mechanical equipment pay in municipal work? It depends on the equipment, the municipality and the work; but in most cases it does, we believe. During the past few years we have described the use of equipment of various kinds by the different departments of a number of cities, and generally satisfactory results were reported. It is unusual, however, to find cost and performance figures as complete as those kept by the Water Department in Baltimore and given in this and next week's issues. Only by a careful and long-time analysis of costs, including overhead, depreciation, repairs, and others, such as lost time of employees due to breakdowns; and of performance, including credit for time saved, can a municipality or contractor decide whether or when the use of a particular kind of equipment is an economy.

Nor should conclusion as to the value of an appliance be reached hurriedly. Certain employees who are prejudiced against an appliance may find it easy to make a poor showing for it; or such a showing may be due to lack of skill in the employee or of his adaptability to a new device or method. Again, the conditions of use may be unfavorable to the appliance; if it be a trench digger, for instance, many boulders or existing house connections in the street it is tried out on may so delay the work or increase the difficulty and cost as to give an unfavorable impression as to the value of the appliance, although if used on another street or after experience had shown how to meet the difficulties, the judgment concerning its value might be entirely different.

On the other hand, in estimating cost of work done by these appliances there is danger that not sufficient allowance may be made for first cost, short life, repairs, loss of time of entire gang should there be a breakdown, number of days per year it can be worked, etc.

All of these points were considered in Baltimore, and we recommend a study of the article referred to, not so much to find out whether the particular devices named were successful and economical in this case as to learn how to arrive at reliable decisions with reference to the use of any appliance in the locality in which the reader is especially interested.

Municipal Bonds

The total sale of state and municipal bonds in June was considerably greater than that of any previous June, having been $116,965,650. Also the sale for the first six months of this year was greater than for any previous similar period, having been more than $499,000,000, according to figures published by the "Daily Bond Buyer," of New York. Last year the sale for the first six months was a little under $349,000,000, which was greater than for any previous six-month period. The most important sale during the first six months of this year was one of $31,800,000 of New York state one to fifty-year serial 5 per cent highway, canal and forest preservation bonds. The next largest was New Jersey's $17,000,000 soldiers' bonus and highway bonds. Other large sales were the municipal bonds of Chicago, Cincinnati, Flint and Pittsburgh and the states of Oregon and Pennsylvania.

Utilizing of Spare Head by Water Works

Several instances exist of unnecessary and even unused head of water in water supply systems going to waste—perhaps more instances than are realized. The utilization of such head at two of the reservoirs of the Boston Metropolitan water system was described in last week's issue and showed profits of $30,000 to $50,000 a year, after making allowance for depreciation and overhead, on an investment of about $224,000, or about 15 to 20 per cent.

Some of the Pacific Coast cities have made the creation of hydro-electric power a very important part of their recent water projects, but eastern

cities, as a rule, have given little thought to this, and it is quite possible that there are a number of gravity supplies that would furnish power from their superfluous heads at little cost. Where an impounding reservoir is more than 250 or 300 feet above the city it will generally be possible to utilize any head in excess of this. Especially favorable is the condition where water from an impounding reservoir flows into a distributing reservoir at a lower level, for here not only can the difference between the elevations of the two be utilized, but the flow can be kept continuous at a uniform rate for any desired number of hours a day, which is not possible when the flow is utilized on its way directly to the distribution system.

Where present construction is not such as to favor a hydroelectric plant, it may still be worth while, in some cases, to establish such a plant by supplementary construction, as by building a secondary dam higher up as a power dam, which will offer the additional advantage of affording more storage of water and regulation of flood flow.

Under modern conditions electric power can almost always find a market, by attracting new industry if there is no existing demand for it, or low-cost power can replace existing power created by steam. But a careful estimate should, of course, be made of the cost of the proposed installation, and revenue assured sufficient to cover all charges, including interest. depreciation and obsolescence.

John F. Wallace

John F. Wallace, past president of the American Society of Civil Engineers, died in Washington, D. C., July 3. Mr. Wallace, who had a high reputation as an executive engineer, was formerly president of the Illinois Central Railroad, and resigned his railroad position to become, for a short time, chief engineer of the Panama Canal. Subsequently he became chairman of the Chicago Railway Tunnel Commission and chairman of the Board of Westinghouse, Church, Kerr & Co., New York.

James Owen

James Owen, a past director and for 52 years a member of the American Society of Civil Engineers, was buried from his residence in Montclair, N. J., May 7. Mr. Owen was one of the last survivors of a prominent group of noted members of the American Society of Civil Engineers, to the interests of which he had always been devoted.

For several years Mr. Owen was engineer of Essex county, N. J. He designed and constructed several sewer systems, including that of his home town, Montclair, and of the Overbrook Asylum. He was eminent in the early development of better roads and was an important factor in making New Jersey the pioneer in the improvement and state control of highways at a time when the most advanced practice, outside of cities and towns, was the construction of high-class Telford macadam pavements.

Until recently Mr. Owen kept up his private practice and maintained offices in Newark, although his winters were generally spent in the south.

American Society For Testing Materials

At the annual meeting of the society, June 21-24, at Asbury Park, N. J., the regular reports that were of special import to public works interests were those of standing committees on Concrete and Concrete Aggregate and on Roads and Paving Materials. Committee C-9 presented tentative standards for making compression tests of concrete; tests of organic impurities in sand for concrete; tests for sieve analysis of aggregate for concrete; methods for securing specimens of hardened concrete from the structure; and specifications for concrete aggregate. It also recommended the adoption as standards of the tentative methods of tests for the unit weight of aggregate for cement concrete and the method for making and storing specimens of concrete in the field.

The lines of research on which this committee are now employed include the Laws of Mechanical Mixes of Cement and Aggregate, Researches on Impurities of Aggregate, Investigation of Coarse Aggregate, the Best Type of Specimen for Mortar Tests, Distribution of Aggregate Materials Throughout the Country, Concrete Specifications, and Testing of Field Concrete After It Is in Place.

Committee D-4, on Road and Paving Materials, recommends slight modifications in existing standards and recommends the standardization of the tentative tests already put out for quantity of clay and silt in gravel highway construction, quantity of clay and silt in sand for highway construction, recommends the continuance for another year of the tentative specifications for block pavement, for workability of concrete, for concrete pavements, for commercial sizes of broken stone and broken slag for highway construction, for commercial sizes of sand and gravel for highway construction, for broken slag for waterbound base, for shovel run or crusher run broken slag for waterbound bases, for natural or artificial sand-clay mixtures for highway surfacing, tests for specific gravity of road oils, road tars, asphalt cement and soft tar pitches, specific gravity of asphalt and tar pitches, sufficiently solid to be handled in fragments, test for quantities of clay in sand-clay, for top soil and semi-gravel for highway construction, and methods for sampling of stone, slag, gravel, sand and stone block for use as highway materials, including some material survey methods.

They also issued a tentative method for test of ductility of bituminous materials, a tentative method for the determination of water in bituminous materials and tentative specifications for calcium chloride for dust prevention, for asphalt cement, for tar for surface treatment, for cold applications, for tar cement for use in cold repair work (cut back product), for tar for surface treatment, hot applications, for tar cement, for coal tar pitch, for block filler.

The report of the executive committee showed

a net increase in membership during the past year of 154, with a present total membership of 2,900. During the year new committees have been organized on Screen Wire Cloth and on Nomenclature and Definitions.

The publication has been commenced of a bulletin particularly designed to afford the committees an opportunity to secure greater publicity of their work as it develops between annual meetings. During 1920 the committees and subcommittees held a total of 90 meetings, the treasurer's report for 1920 showed assets and liabilities of $27,594.52, with total receipts during the year of $57,777.88 and cash on hand of $265.05.

During the year the society has continued to take an active part in the work of the American Engineering Standard Committee and five of its tentative standards have been approved by the latter. The society is co-operating with the American Society of Mechanical Engineers' Boiler Code Committee and with the Government and the American Petroleum Institute, with the Society of Automobile Engineers, the American Society for Steel Treating and with the division of engineering of the National Research Council. It has participated in the work of the joint committee on the Investigation of Phosphorous and Sulphur in Steel, on Standard Specifications for Concrete and Reinforced Concrete, on Concrete Culvert Pipe and on Standard Pattern Practice.

Concrete Arch Bridges

By B. H. Davis, C.E.*

The development of enduring, safe and artistic highway arch spans has been accomplished within the present generation, coincident with the quantity production of Portland cement, and provides for a great variety of structures of unlimited capacity, built by simple methods, with local materials and labor, and with notable ultimate economy.

Beginning 4,000 years ago with the three-voussoir five-foot span arch found in a Theban tomb, which may be considered to represent the first elements of arch construction, arch bridges developed through many centuries.

The bridges of the Roman era with stone spans of less than one hundred feet maximum have proved enduring even to the present day, not only for military and civil purposes, but for the domestic welfare of towns and cities to which they brought supplies of mountain water in their famous aqueducts such as Claudia, Segovia and Pont de Guard.

After the fall of the Roman Empire and the decline of the Roman builders, bridge construction was at a standstill for many centuries and very few important bridges were built except by the Moors in Spain.

Some crude attempts to extend stone arch bridge construction by the use of wooden arches were made during the dark ages (500 to 1100 A. D.), of which we have imperfect records of a few containing spans up to 100 feet in length.

The civilization which had been built up by the Romans in Southern Europe, in France and Britain went into decay and it took nearly 500 years for the civilized world to recover. The races which became the governing powers had but little use for the artistic and beautiful and the conveniences of the civilization developed by the Romans.

The finely constructed bridges and aqueducts ceased to be maintained and these magnificent structures became ruins. Whenever bridges were constructed they were poorly and cheaply made, very narrow, seldom more than 20 feet in width, and in every way inferior to those of the Romans.

MODERN PROGRESS

No particularly noteworthy progress was made in bridge building from the time of the Romans until about 125 years ago, when a number of cast iron arch spans were built in England.

A further impetus to bridge building was given by the early settlers in America where the enormous quantities of splendid timber encouraged the use of framed structures, the design of bridge trusses was practically inaugurated, and spans of wood alone were built up to 200 feet in length, including some famous old arch trusses. From wood, combined with wrought iron tie rods, the Howe trusses were developed and further progress carried those spans to a limit of 200 to 300 feet.

The next step was the introduction of cast iron for details and minor portions of these bridges, followed soon by replacement of the wooden members with cast iron members, both in the trusses and in the elements of the arches.

A little later, almost within the memory of the junior members of this society, a considerable advance was attained by the use of riveted wrought iron members, thus making the bridge trusses wholly of wrought iron and extending their spans to a maximum of 550 feet, which about 40 years ago was considered a great triumph.

Eventually the replacement of wrought iron by steel has enabled the spans of bridge trusses to be increased to the maximum of 1,800 feet, at-

* Address delivered to Rochester Engineers' Association, May 13, by the designer of the 450-foot span concrete arch of the Ridge Road Highway bridge now under construction across the Genesee River gorge at Rochester, N. Y. Numerous stereopticon slides were shown, illustrating ancient and modern arch bridges and the methods of constructing the latter.

tained three years ago by the famous and ill-fated Quebec Bridge, almost 100 feet in excess of the world-renowned Firth of Forth bridge in Scotland.

While trussed spans attained this remarkable development, masonry structural development stood practically still for centuries, the limits considered possible for cut stone arches with few exceptions being but little greater than they were in the time of Christ.

THE RAPID DEVELOPMENT OF CONCRETE ARCHES

The Romans developed remarkable success with their famous concrete, but it was carried no farther until within the last two generations when the scientific manufacture of hydraulic cement became more general and larger quantities of this material were available.

American engineers were quick to see the tremendous possibilities of this new material which permitted the construction of what is practically artificial stone in unlimited quantities of any desired dimensions.

Its application to arch bridges was rapid and successes were brilliant. Their spans thirty years ago probably nowhere exceeded 100 feet and very seldom exceeded 40 feet, being considerably below the upper limits of masonry arches.

Such engineers as Edwin Thatcher, Jean Monier and Prof. Meland devoted themselves to the mathematical analysis and mechanical features of concrete arch construction and devised several types of structures, such as the hinged, hingeless, barrel vault and ribbed types of arches with various kinds of spandrel treatment and floor construction which were adaptable to most highway, and even to railway, requirements.

With the increasing facility in construction methods, through improved plant and appliances for their construction, the cost of arch bridges decreased and the available dimensions increased until we now have existing spans 328 feet in length with others under construction of 400 feet clear and still others contemplated and already designed having spans 425 to 703 feet clear opening, and it is of these examples of the bridge builders' art that I wish to present to you some of the essential features and describe the methods involved in their design and construction.

GOVERNING FACTORS OF DESIGN

The capacity of a bridge must necessarily be determined by the local requirements, as well as by the available resources, and the latter should, if possible, conform to the true economies of the problem.

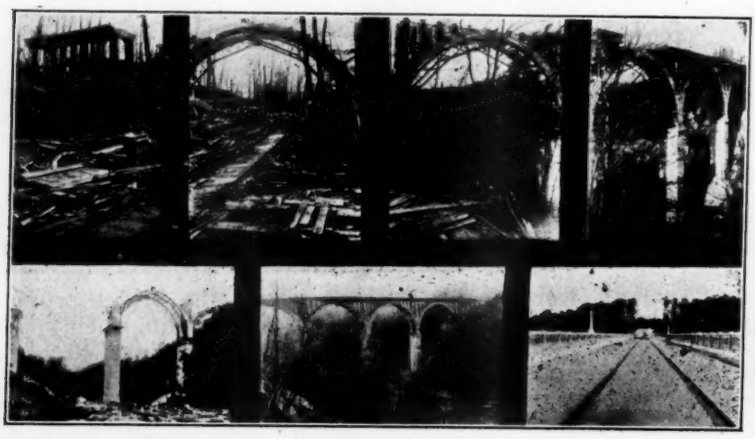
The capitalized valuation of the structure must be compared with its ultimate cost. When this is done it will be found that although other types of bridges may sometimes be erected for a smaller initial cost, the final cost, after a period of 20 years, to which we may add 50 to 100 years which the concrete bridge may be safely expected to endure, will be far less for the concrete structure since its maintenance under proper conditions may be almost disregarded.

IMPORTANT ADVANTAGES OF CONCRETE ARCH SPANS

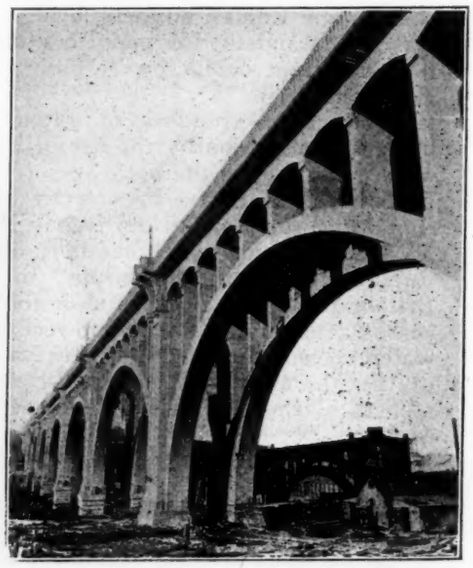
One great advantage of the concrete bridge is that it is almost impossible to make it too light, in other words, the minimum of material necessary for the mechanical operations of its construction afford a margin of strength considerably greater than is necessary to carry the dead load of the structure and this margin of strength is generally abundant for any live load that may be imposed.

With strength the fundamental principle of the design, which always compels the designer to give recognition to live load that can under no practical conditions exceed the capacity of the bridge, a concrete bridge may be safely expected to carry any increase whatever that may occur in traffic conditions, no matter how unexpected and enormous they may prove to be.

Concrete also, through its plastic nature, lends itself more than any other material to architectural and artistic treatment and permits arch structures to combine to the utmost strength and symmetry that lend dignity and elegance, therefore making them with very little if any extra expense quite ornamental, and often monumental in their character.



ERECTION, ON STEEL TRUSS CENTERS, OF VIADUCT AT AKRON, O.



VIADUCT AT ALLENTOWN, PA.

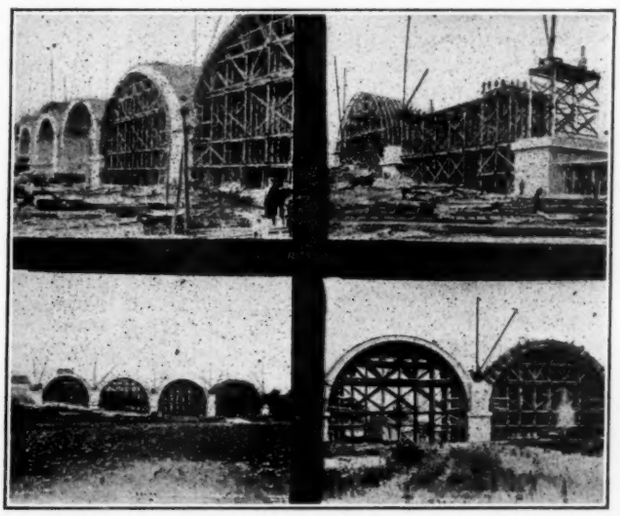
Furthermore, the construction of a concrete arch is one of the most independent of all engineering operations, since it generally is built almost wholly of local materials, easily procured at any time by simple methods, depending to a very small degree on imported materials, and as a rule it can be erected under competent supervision by local labor, requiring few trained or skilled workmen.

ESSENTIAL REQUIREMENTS

In general, it suffices that a concrete arch bridge should be carefully planned to meet the best requirements of the situation, should be designed by an experienced engineer and should be erected under his strict and constant supervision. These requirements having been met, it may be safely assumed that a concrete arch will be a thing of beauty and a joy forever.

The mathematical features of analysis and design of a concrete arch do not need to be enlarged upon before this audience. It is a matter of choice between the different types of arch rings and revisements, all of which can be analyzed and proportioned by the usual graphical and analytical methods.

The construction of an arch bridge, however, is a more difficult matter, which can properly be appreciated or criticized by comparatively few

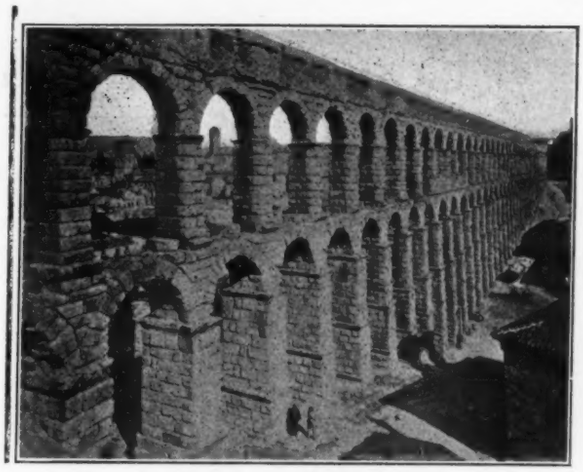


ERECTION, ON WOODEN FALSEWORK, OF PAULING KILL RAILROAD BRIDGE

engineers, who have had an opportunity to witness or participate in their construction so that experience really must be the principal guide.

It will suffice here to show you a few views of arch bridge work of various sorts under construction, and to remind you that the principal anxiety of a bridge builder is in regard to the foundation conditions, the height of the structure, the depth and velocity of the stream at various stages, the danger from ice and drift, the possibility of interruption to navigation, the provision for traffic and the support of the wet or plastic concrete until it attains a strength sufficient to form a safely self-supporting arch.

The sub-structure is a vital part of the arch bridge and must be built beyond all possibility of settlement during construction. The piers and



SEGOVIA AQUEDUCT, SPAIN

abutments may, under favorable conditions, be built on the surface of the rock or in any satisfactory excavations, benches or stops cut in same. At other times they must be built in cofferdams and even by pneumatic caisson methods.

CONSTRUCTION OF SUPERSTRUCTURE

After the piers and abutments are provided, some sort of temporary support between them is necessary to carry the enormous loads of wet concrete. This is ordinarily provided by the familiar trestle or wooden falsework, consisting of transverse bents, supported on sills or piles, or by fan-shape braces radiating from the pier footings for short spans.

For longer arch spans of 100 feet or more falsework trusses temporarily spanning from pier to pier are usually employed and moved from span to span as the work progresses. These trusses for shorter spans may be made of timber, but generally, especially for multiple service, they are made of riveted steel members, and are practically equivalent to steel bridges themselves, being used over and over again and forming a part of the contractor's permanent plant.

These support the curved platform or lagging on which the arch or arch ribs are concreted in simple forms similar to those with which you are familiar for any mass concrete work. With their completion, the falsework, of whatever nature it may be, is lowered and released from the weight of the concrete and moved away, the spandrell construction and the floor system are subsequently built by ordinary concrete methods and supported during construction by the arch itself.

It remains for the contractor to devise economical, efficient and rapid methods of mixing, handling and placing the concrete and reinforcing materials. The former is usually attained by providing elevated storage bins for his aggregate and powerful engine driven machines for mixing.

The concrete in batches of one-half yard to one yard or even more is discharged from the mixers into buckets or dump cars and is transported, lifted or spouted to the forms for the arch ribs or super-structure by derricks, by cableways, by dump cars on elevated or depressed service tracks or by towers and spouting systems.

Construction Questions Answered

Suggestions as to methods, "wrinkles" and appliances that may be used to overcome difficulties arising in construction work. We invite questions concerning such problems that may arise from time to time in the experience of any of our readers. Answers prepared by competent authorities will be published promptly. It is hoped that others who have solved similar problems differently will send us their solutions for publication also; or describe new "wrinkles." If it is only a new way to drive a nail, it may help some one.

How to Drive Wooden Piles–III*

Handling piles, starting and driving, cutting off, pulling with tackles, levers, jacks and hammers, driving with water jets, screws and explosives., Rapidity of driving.

As driven, each pile is generally snaked to the driver by the pile line which is attached to it by a chain fastened to the point and pulls it a maximum of 400 or 500 feet to the machine where the hitch is shifted to the butt and the pile hoisted into vertical position and placed between the ways. It is usually held back against the rear of the ways by a line that is eased off as the pile penetrates, and is adjusted a little and sprung from side to side by handspikes levered against the ways as required.

The location of each pile is determined from centers given by the engineers, and is marked by a stake driven by the contractor. Care is taken to spot the pile within 1 or 2 inches of the exact center, and it is driven as accurately as possible, but it is subject to possible displacement by obstructions or careless driving. Some displacement may be corrected by careful driving, but if it is greater than 12 inches the pile is usually pulled and redriven, or another pile is driven to replace it. For timber trestle work and where piles are capped with timber sills or grillages, greater accuracy of position is required than where, as is frequently the case, their tops are embedded in a concrete footing.

PRACTICAL CONSIDERATIONS

An experienced driver will regulate his blows so as to produce the maximum penetration and the least danger of injury to the pile, he will keep his pile plumb, on center, and select it for the minimum waste. When a pile encounters subterranean obstructions they can generally be recognized by the rebound of the hammer and by the sound of the blow, which will also tell the experienced driver when the end is brooming. A sudden acceleration of the penetration or of the transverse displacement or deviation from the vertical after hard driving is likely to indicate a broken pile.

When a large number of piles are driven on very close centers, especially in sandy soil, it is well to commence driving at the center of the group and work outwards, thus making the penetration easier and reducing the tendency of the new piles to crowd out the others, sometimes raising them a number of inches and necessitating redriving.

When very long piles are required they may be secured by splicing two shorter piles. Formerly this was done by bolting wooden fish plates on both sides of a butt joint, as was done for the 120-foot piles for the falsework of the intermediate 500-foot spans of the Poughkeepsie bridge that were driven through about 60 feet of water into deep, soft mud. The best present practice is to secure a short section of extra heavy steel pipe of the required diameter and fit it carefully to the adjacent ends of both piles that are cut square so as to take bearing on each other in the center of the sleeve enclosing them.

DRIVING EXPEDIENTS

In starting a pile of nearly the full length of the ways, there is sometimes so little clearance for the hammer on the head of the pile that the first strokes must be very short. If these are too short the difficulty is sometimes remedied by spudding, that is, a shorter pile is placed in the leads, driven a few feet, withdrawn, and the permanent pile promptly placed in the hole thus prepared where it settles or is easily driven far enough to allow a satisfactory hammer blow to be delivered to it.

In hard loam or clay it is sometimes very advantageous to soak the surface of the ground thoroughly by a hose stream directed alongside the pile point when or before driving is commenced. This will often quickly soften the ground enough for the pile to penetrate a few feet very easily and be securely held in position under the first light blows that become rapidly more effective.

When piles are to be driven below the bottom of the tower sills, and often in driving them below the surface of the water, a follower is used, which consists simply of a short length of a heavy pile, and usually is connected to the top of the pile, generally by a detachable sleeve or socket or sometimes with a dowel, and has the upper end arranged to engage a sliding block in the guides

*Part I, General conditions and requirements, number, size, penetration, refusal, capacity, calculation, tests, pointing, cutting, banding, hand and horsepower driving was published July 2.

Part II, Drophammers, towers, cantilever and turntable drivers, penetration, steam hammers and double-acting hammers was published July 9.

and receive the blows from either steam or drop-hammer.

PULLING

When piles are pulled soon after being driven, it is generally accomplished by a six-part pulling tackle that can exert a strain of perhaps from 30 to 50 tons, according to the efficiency of the hoisting engine. If the pile has long been driven it is customary to strike it one or two blows with the hammer to dislodge it before pulling. It is also sometimes helpful to clamp or cramp bearings on the pile and operate jacks against them which will greatly facilitate the pulling in very stubborn cases. After the pile starts to rise and the adhesion of the ground is broken it is pulled much more easily than at first and the jacks may be replaced by tackles.

When there is plenty of space between piles and they do not have to be fitted to timber caps it is quicker and more economical to chop off the tops to the cut-off line. In other cases they are usually cut off with accuracy by two men and a cross-cut saw, the latter being lined up by a pair of carefully leveled horizontal battens temporarily nailed to opposite sides of the pile at cut-off line. About 40 piles in 8 hours would be a fair record for cutting off with two men and a saw. If accuracy is not required the tops are often chopped off with axes and if the pile tops are cut off under water it is generally done with a belt-driven circular saw mounted on a vertical shaft and arranged for adjustment at any elevation.

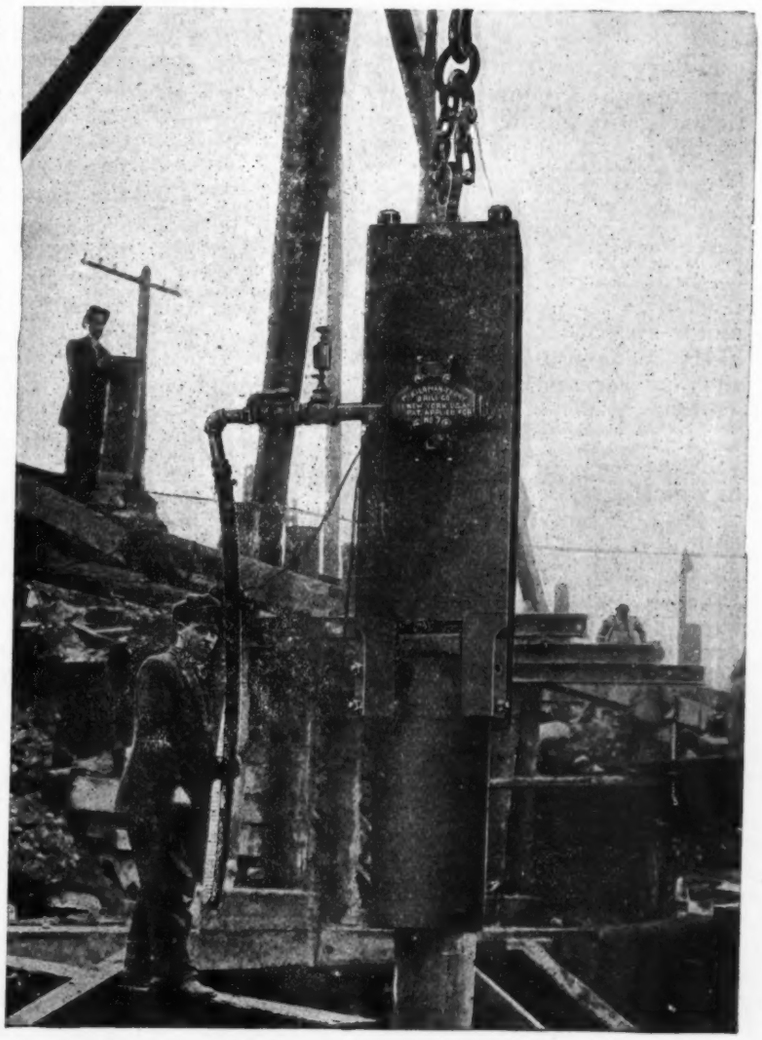
A great advantage of the double-acting hammer is that by reversing its action it can be made to pull piles with the same facility and about the same speed with which it drives them. This is effected by inverting the hammer and attaching it with a strong connection to the top of the driven pipe. If the hammer is maintained in a vertical position and a constant lifting tension is applied to it, its operation will start the pile moving upwards at about the same speed at which it moved downwards; at the completion of the driving and after the motion is well established the hammer may be removed and the pile withdrawn by the use of an ordinary tackle.

This method of pulling has become standard and has been very satisfactorily used on a large amount of important work where piles have been pulled that it was estimated would have required 100 tons tension of a powerful tackle if the hammer had not been operated on them. The pulling is prompt and successful in many cases where ordinary tension or even the operation of jacks would be exceedingly slow or inefficient.

The harness with which the hammer is attached to the pile must be very strong and well adjusted to endure the severe duty. It may be made of welded steel bars or it may consist of a lashing of steel wire ropes, which is much cheaper and simpler than the welded frame and will suffice for ordinary work, although it cannot be easily made as strong as the welded frame.

For driving piles through sand, gravel and some other materials, great advantage is often derived by the supplementary use of a hydraulic jet carried down with the pile or in advance of it to soften the ground, scour out a hole, and often to undermine large stones and cause them to sink through the soft material in advance of the pile. Water at from 1 to 200 pounds pressure or more is delivered through a flexible hose connection to a steel pipe detachably connected to the pile and is discharged through a nozzle at the lower end of the pile. The nozzle may be circular up to ¾ inch diameter or flattened to a width of about 2¼ inches, or shaped to give the water a whirling motion, which is considered advantageous.

In sand or in other loose material, the hydraulic



McKINNON-TERRY DOUBLE ACTING STEAM HAMMER WITH ATTACHED SLEEVE CAP, DRIVING PILE WITHOUT LEADS.

jet is sometimes so efficient that it alone suffices to sink the pile to a considerable depth, and may, under certain circumstances, be entirely sufficient for the operation, although it is generally accelerated and improved by starting the pile with a few light blows with a hammer, repeated at the end of the operation to set it firmly in position. If a hammer is not available the pile may sometimes be forced down by loading it, and jetting, or by applying pressure through a long lever.

In very soft material like silt or thin mud, a pile may be driven to considerable penetration by loading or leverage alone without the jets, but in any case the penetration will be accelerated by the addition of some impact either from a light drop hammer or even from a very heavy hand sledge, maul or battering ram. Small groups of foundation piles for highway bridges in a New England state were driven by hand with a short, heavy green log used for a hammer.

SCREWED PILES

Steel or iron, solid or hollow piles are sometimes screwed down in soft ground when they are provided with a sort of screw point having wide spiral flanges with a long pitch and are equipped with a hand or power device for revolving them around their vertical axis. The same sort of screw point might be attached if necessary to the bottom of a wooden pile if the conditions and requirements were favorable, particularly if it was desirable to resist upward pull on the pile in service or to secure extra bearing in very soft material.

The screw thread or flange can be made of cast iron or bent steel plates and provided with a socket to fit the end of the pile. The pile can be turned by capstan bars applied to the head, by tension on a rope around the pile, or by gear and motor attached to the pile. This method is not likely to be ordinarily desirable, but may possibly be used in case of special requirement or emergency.

DRIVING BY EXPLOSIVES

Piles have been driven by the explosion method, in which a small chamber is provided in the top of the pile and small charges of gunpowder are fired in it by the action of a light hammer falling on the pile. About 4 ounces of gunpowder is sufficient to drive a pile 20 feet into the mud and about 21 ounces will drive it the same distance in gravel. Piles have also been driven to moderate depths by small charges of dynamite exploded on iron plates laid on the tops of the piles.

When piles are driven with single or double-acting steam hammers or with drop hammers operated by steam power, the number of piles driven per day depends on the length of pile, the character of the soil, the efficiency of the hammer and of the crew and very greatly on the location and arrangement of the piles.

Under the most favorable conditions, where the ground is soft and free from obstructions and the piles are spaced close together in long continuous rows from 50 to 100 piles may be driven to a penetration of 30 or 40 feet in 10 hours by a crew of ten men, operating a drop hammer and 50 or 100 per cent more may be driven under the same conditions with a steam hammer.

Ordinarily a large part of the time is required for shifting the machine and for placing the piles. When this is reduced to the minimum and all the delays are eliminated, very rapid driving and consequently low costs may be secured. All other things being equal, the driving is more efficient, the results are better, and the working value of the pile is greater for piles driven rapidly than for those driven slowly. By careful watching an experienced driver can interpret the behavior of the pile and the hammer so as to form a pretty fair opinion of subterranean condition and the condition of the pile itself. On important work it is desirable that a careful log should be kept of the driving of occasional piles, enough, at least, to indicate any material changes encountered.

Cement Manufacturers' Combine Sued

Under orders from Attorney-General Daugherty suit was brought June 30 in the United States District Court, New York City, for an injunction against and dissolution of the Cement Manufacturers' Protective Association and its officers and members.

The officers of the association are E. P. Alker, President; C. Raymond Hulbert, secretary; and Marion S. Ackerman, treasurer.

The Attorney-General said this association produced approximately 90 per cent of the total Portland cement used in the northeastern part of the United States.

The proceedings will supplement criminal action instituted last March, and will not stop its prosecution. The court may order an effective dissolution of the combination and enjoin its members from reconstituting their association, thereby affording the public substantial and practical relief without regard to results in the criminal case.

Members of the association named in the complaint are the Atlas Portland Cement Company, Allentown Portland Cement Company, Alpha Portland Cement Company, Bath Portland Cement Company, Coplay Manufacturing Company, Dexter Portland Cement Company, Edison Portland Cement Company, Giant Portland Cement Company, Glens Falls Portland Cement Company, Hercules Cement Corporation, Knickerbocker Portland Cement Company, Lawrence Company, Lehigh Portland Cement Company, Nazareth Cement Company, Penn-Allen Cement Company, Pennsylvania Cement Company, Phoenix Portland Cement Company, Securities Cement and Lime Company and the Vulcanite Portland Cement Company.

The Cement Manufacturers' Protective Association is organized for the exchange between members of comparative statistical data which enables each to know what his competitors are doing. For some time past the investigation of every complaint of an alleged violation of the Sherman anti-trust act has invariably led to the doors of one of these associations.

Recent Legal Decisions

ADJUDICATED BALANCE DUE ROAD CONTRACTOR HELD ASSIGNABLE

The Mississippi Supreme Court holds, McGraw v. Board of Supervisors of Winston County, 87 So. 896, that when a contractor has constructed public roads in a county or subdivision thereof, and such roads have been completed and accepted, and the balance due such contractor for the construction of the roads has been finally adjudicated by the board of supervisors, and there only remains the duty of ordering the issuance of a warrant for this balance, the contractor may assign this balance due to him, and the assignee thereof may maintain mandamus to compel the board of supervisors to issue to him a warrant for the balance so assigned.

MISSTATEMENT IN ORDINANCE OF PRO RATA COST OF PAVING IMPROVEMENT WILL NOT INVALIDATE CONTRACT

The Ohio Supreme Court holds, City of Newark v. Fromholtz, 130 N. E. 561, that a mistake in publishing an "ordinance to proceed" with a paving improvement, where such mistake is confined to misstating the pro rata proportion or percentage of the cost of the improvement to be assessed against abutting property, is not a defect fatal to the legality of the publication of the ordinance and a contract authorized and directed to be entered into by the terms of such ordinance will not be held to be invalid for that reason.

PROPER CHARGES IN MATERIALMAN'S ACTION ON ROAD CONTRACTOR'S BOND

In a materialman's action against a surety on a road contractor's bond conditioned for payment of supplies or provisions furnished for the prosecution of the work, the Oregon Supreme Court holds, Clatsop County v. Feldschan, 196 Pac. 379, that an amount due for horse feed furnished was a proper charge against the surety, and also the amount due for feeding the contractor's employees, but not sums for tobacco, cigars and cigarettes furnished the men, nor expenses for procuring knives, forks and dishes.

CITY NOT LIABLE FOR DEFECTIVE FOOTBRIDGE BUILT BY RESIDENTS ON ITS PROPERTY

Before a city can be held liable in an action for personal injuries because of a defective footbridge, both pleading and proof must show an obligation to the plaintiff on the part of the city which has been violated. And where it appears the footbridge was constructed by neighboring residents on park and boulevard property for neighborhood convenience, but not constituting a part of the city's public ways, it was held that the city was not liable, it not having accepted the bridge, nor by any act invited the public to use it as part of its public highway system. Dering v. City of Cleveland, Ohio, Supreme Court, 130 N. E. 504.

ORDINANCE AS TO TEMPORARY OBSTRUCTIONS IN STREETS UPHELD

The Ohio Supreme Court, City of Xenia v. Schmidt, 130 N. E. 24, upholds the constitutionality of an ordinance of the city of Xenia making it unlawful to place on the streets or sidewalks of the city any wood, coal, box, merchandise, etc., or any other material or obstruction whatsoever, unless for such reasonable time as may be necessary to load or unload same from any building, and unless the public passage shall not be blocked; the provisions not to apply to permanent structures. It is held that a classification of street obstructions into temporary and permanent, and providing that the ordinance shall operate only upon temporary obstructions, is a real and reasonable classification, and does not violate any provision of the state or the federal constitution.

DIRECTIONS TO ROAD CONTRACTOR NEED NOT BE ENTERED ON MINUTES WHERE POWER OF SUPERVISION RESERVED

Where there is a valid contract in existence between a board of county commissioners and a contractor for the construction by the latter of a public road, which contract reserves to the commissioners and their engineer the direction, supervision and control of the work in a manner specifically detailed in the contract itself, the Ohio Supreme Court holds, Putnam v. Board of Commissioners of Paulding County, 130 N. E. 165, that directions given by the board or its engineer, under such reserved power, are not required to be entered on the minutes, or to be in writing, in the absence of express provisions in the statute or the contract to that effect.

CONTROL OF COUNTY ROADS BROUGHT WITHIN CITY LIMITS

Under the Texas statutes an incorporated city or town has the exclusive control of all the streets and highways within the limits of the corporation, and when such corporation in its creation or by subsequent extension embraces within its limits a portion of a public county road, such road becomes thereafter a street of the city and is no longer subject to the control of the county, and all the rights of the county in such highway pass to the city. Feris v. Bassett, Texas Court of Civil Appeals, 227 S. W. 233.

ASSESSMENTS FOR SEWER IMPROVEMENTS — ENHANCEMENT OF VALUE

The Illinois Supreme Court holds, in a proceeding by a village for the establishment of a sewer improvement, Village of Bradley v. New York Central R. Co., 129 N. E. 744, that the fact that certain property affected by the improvement was at the time provided with sufficient sewer facilities for its present use would not relieve it from assessment if the effect of the improvement would be to enhance its value for the use for which it was best adapted.

NEWS OF THE SOCIETIES

Aug. 10-12—INTERNATIONAL ASSOCIATION OF STREET CLEANING OFFICIALS. Annual conference. Hotel La Salle, Chicago, Ill.

Aug. 23-25—AMERICAN ASSOCIATION OF PARK SUPERINTENDENTS Annual meeting. Detroit, Mich. Secretary, Emmet P. Griffin, Superintendent of Park, East St. Louis, Ill.

Aug. 30-Sept. 1—MICHIGAN STATE GOOD ROADS ASSOCIATION. Annual meeting. Flint, Mich.

Sept. 13-16—NEW ENGLAND WATER WORKS ASSOCIATION. 39th annual convention. Bridgeport, Conn. Secretary, Frank J. Gifford, 715 Tremont Temple, Boston, Mass.

Sept. 28 (10 days)—NEW YORK ELECTRICAL EXPOSITION. Seventy-first Regiment Armory, New York City.

Oct. 11-14—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Annual Convention, Atlanta, Ga. Hotel Ansley. Secretary, James J. Mulcahey, Municipal Building, Denver, Colo.

Oct. 24-28—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention. Southern Hotel, Baltimore, Md. Secretary, Charles Carroll Brown, Valparaiso, Ind.

Oct. 31-Nov. 5—NEW ENGLAND ASSOCIATION OF COMMERCIAL ENGINEERS. Power show in connection with INTERNATIONAL TEXTILE EXPOSITION. Mechanics' Building, Boston, Mass. Secretary, James F. Morgan, Devonshire st., Boston.

Nov. 14-18—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting. New York City.

AMERICAN ASSOCIATION OF ENGINEERS

The board of directors met in Chicago June 24-25. Out of 16 directors 14 were in attendance.

The country was divided into 12 districts. Provision was made for continuing the Washington office for the balance of the year. A committee of 15 was appointed to draft a plan for financing the employment service, including a consideration of requiring contributions from recipients of the service as provided in the resolution adopted by the seventh annual convention in Buffalo in May.

A committee of five was appointed to amplify the statements and objects of the association. A very forward looking step was taken to further one of the principal objects of the association "to raise the standard of ethics of the engineering profession" by an invitation issued in the name of the board of directors to all engineers, whether members of of A. A. E. or not, to submit questions of ethics to the board for reference to the practice committee. After a sufficient number of cases, both hypothetical and actual, have been passed upon by the practice committee and approved by the board, they will be published in pamphlet form for general circulation.

An administrative board was appointed to supervise and direct the policy of the professional engineer. The board authorized the committee on services and fees of practicing engineers, of which Langdon Pearse, of Chicago, was made chairman, to hold a national conference of practicing engineers at such time and place as the committee may decide.

A committee of three consisting of President Garman, Secretary Drayer and First Vice-President Johnson was appointed to meet with a committee of three appointed by the executive board of the American Engineering Council to study relations and cooperation.

ENGINEERING SOCIETY OF AKRON

The Engineering Society of Akron has elected the following officers: President, J. H. Vance; vice-president, L. G. Tighe; directors, R. R. Metheany and H. G. McGee; and secretary-treasurer, H. G. McGee.

PORTLAND POST, SOCIETY OF AMERICAN MILITARY ENGINEERS

At its annual meeting on June 13, the Portland (Ore.) post of the Society of American Military Engineers elected the following officers: President, F. S. Cook; vice-president, P. Hetherton; secretary, E. B. Thompson; treasurer, S. C. Schubert; and assistant treasurer, A. D. Montieth.

INDUSTRIAL NOTES

The San Francisco office of the Pawling & Harnischfeger Co., of Milwaukee, has been moved from the Monadnock building to 32 Beale street, where the company maintains a complete service station, warehouse and display room for crane and hoists, machine tools and excavating machinery.

Mr. R. M. Taylor, district manager for the Pacific Coast, has his headquarters now at the Beale street address.

Prof. Charles A. Ellis, of the University of Illinois, has resigned to become vice-president of the Strauss Bascule Bridge Co., of Chicago.

The National Engineering Company has been organized by I. Muschel, formerly inspector of construction, Navy stations, Pensacola, Fla., and Norfolk, Va., to specialize in the design, erection and construction of structural steel and reinforced concrete buildings.

The firm of Gibbins & Brown has recently been organized by J. O. G. Gibbons and C. E. Brown. It will specialize in power plants and industrial problems and will be located in Newark, N. J.

The Davenport Electric Company has been formed at Davenport, Ia., by H. M. Heysinger and Richard Copely.

The Dayton-Dowd Company, manufacturers of centrifugal pumps, of Quincy, Ill., announces the opening of a new district office for the sale of pumping machinery in the Pioneer building, St. Paul, Minn., in charge of George M. Kenyon Company. The firm consists of George M. Kenyon, president and general manager; Robert D. Lewis, vice-president; and James C. Willson, treasurer, all of whom are engineers of long standing in St. Paul and are all well acquainted with the power plant, railroad, and municipal field.

CLEANING BRICKS WITH PNEUMATIC HAMMERS

A prominent engineering construction company using Boyer type BB chipping hammers made by the Chicago Pneumatic Tool Company, and fitted with extra wide-faced chisels, cleaned 3,000 bricks per day at a saving of 75 per cent in cost over the previous average of 650 bricks per day by hand. The hammers used were 1 3/16-inch bore by 1½-inch stroke, consuming 12 feet of air per minute. The blows delivered by the hammers were not heavy enough to damage the bricks, yet sufficiently effective to remove all old mortar and dirt.

About 100 bricks were laid side by side on the table, forming a comparatively flat 12 x 3-foot surface, which the operator cleaned before turning the bricks for cleaning on the ends and other sides.

With a labor cost of 40 cents per hour, the same as for hand methods, the pneumatic method cleaned five times as many bricks. The cost of compressed air averaged two cents per hour per hammer. The cost per thousand bricks, hand cleaned, was $5.55; mechanically cleaned, $1.26.

A 1,200-FOOT FLORY CABLE WAY

The contractors for the construction of the Gilboa dam have installed on that work for handling concrete and other materials a cableway 1,900 feet long, equipped with machinery made by the S. Flory Manufacturing Co., Bangor, Pa. The towers are 140 feet high and the the S. Flory Mfg. Co., Bangor, Pa. The towers are 140 feet high and the main cable is a Leschen Hercules 2½-inch x 19 Lang Lay rope, parallel to and 6 feet eccentric from the axis of the dam. It is equipped with ¾-inch operating rope, also of the Hercules brand. It is designed to handle loads up to 10 tons with a conveying speed of 1,200 feet per minute, hoisting on a 3-part line at 400 feet per minute. It is provided with an aerial dump controlled by a rope operated by a third drum.

All of the three drums in the cableway hoist engine are placed tandem and are 16 inches in diameter x 48 feet long between flanges. They are driven through machine cut steel gearing by a 300 h. p. General Electric I. T. C. type motor, making 600 r. p. m. and equipped with multiple torque solenoid brakes and operated through full magnetic contactors control with master switch.

PERSONALS

Wheaton, L. H., has been appointed commissioner for the county of Cape Breton, with headquarters at Sydney, B. C.

McCluskey, Jr., W. O., has resigned as road engineer of Ohio county, W. Va., to become assistant division engineer for the third district of the State Road Commission.

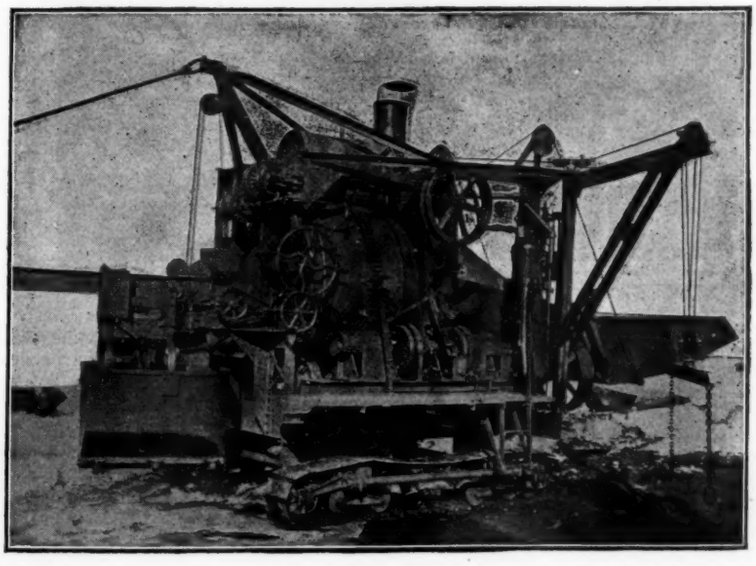
Francisco, J. O., formerly field engineer of the Colorado State Highway Commission, is now road engineer of La Plata county, Colo., in charge of maintenance and construction of 1,600 miles of road.

Brewer, T. M., has been appointed city engineer of Viroqua, Wis.

Dollard, E. C., has resigned as city engineer of Jamestown, N. Y.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations



PAVER WITH CAPACITY FOR MIXING DRY BATCH IN 12 SECONDS

RANSOME 21-E HEAVY PAVER

The Ransome 21-E new heavy paving mixer combining unusual speed with positive one-man operation will, it is claimed by the makers, discharge dry mix in from 10 to 15 seconds, with an average time of 12 seconds. In comparing the 21-E with the old 14-E, it is interesting to note that the new paver has 10 per cent less parts.

The control levers are arranged so that without taking a step the man running the machine can easily and continuously carry on all required operations, such as lifting batch boxes from an industrial truck, raising the skip, admitting the water, swinging the boom, dumping the mixer, running the bucket out on the boom, dumping the bucket and returning the bucket to the mixer. The crawler mechanism used is an adaptation of the well-known and thoroughly developed full crawler traction used for "Marion" steam shovels. A friction clutch is placed on the countershaft; and each crawler is furnished with a separate drive. There is a separate band brake for each crawler, which assists in making short turns.

All operations of the crawler are controlled by a clutch lever, reversing lever, steering lever, and two foot brakes.

The drum roller shafts are of cold rolled steel fitted with rollers of car wheel metal 16 inches in diameter and mounted on Hyatt roller bearings. The drum is of all steel plate construction, lighter and stronger than cast steel drums, requires less power for revolving, will not break when pounded, and is less likely to be damaged by the freezing of water in it. The drum roller tracks are forged and rolled from billets of locomotive tire steel. The operator can at all times see into the drum. Every operating part of the machine is easily accessible, and there are no parts revolving when not in use. This point particularly applies to the traction clutches and other driving mechanisms, none of which are running except when the crawler is in use.

"Knocked down," ready for travel or shipment, the Ransome 21-E is but 11 feet in height. Two men and a wrench can dismantle or erect the Ransome 21-E in 30 minutes.

The loading derrick is designed to be placed on either side of the machine, and can be easily shifted from one side to the other. Its height will permit the lifting of a batch box directly from a motor truck. A ratchet is provided for holding the load at any point.

The power loader bucket is of the open end type, wide enough at the bottom to permit motor trucks to dump direct, or for two wheelers to dump at a time. When fully raised the bucket has a 48 degree slope insuring quick, clean discharge. The power loader hoist is equipped with a friction clutch, automatically released when the bucket reaches its maximum height, at which point the clutch brake automatically sets, holding the skip in discharge position.

The paver can be equipped with either steam power, gasoline or electric motor drive. Where steam power is desired, the paver is equipped with a 14 h. p. engine, fully enclosed with counterbalanced crankshaft, and a 16 h. p. boiler built to A. S. M. E. specifications. The exhaust is piped into the base of the stack to increase the draft. A blower is also provided for raising steam before the mixer gets into operation.

With gasoline drive a heavy duty tractor type engine rated at 25 h. p. at 900 r. p. m. is used.

DUPLEX LIMITED

The Duplex Limited four-wheel drive trucks, put on the market by the Duplex Track Company, have been designed in response to a general growing demand for a high-grade truck of medium capacity with unusual speed. It has a four-cylinder motor rated at 25.6 h. p. and developing by actual brake tests 42 h. p. at 1,600 r. p. m. It has a duplex radiator and a 13-inch fan, electric starter and lighter, and direct high speed drive with ratios of 3.66:1, 1.91:1, and 1.00:1 with 4.46:1 in reverse.

LINK BELT STONE HANDLING MACHINERY

Catalog 416 of the Link Belt Company has numerous halftones and diagrams illustrating the descriptions of the apparatus and methods for handling broken stones to and from the crusher and storage bins and for conveying them vertically, horizontally and in an inclined plane.

A convenient portable outfit consists of a bucket elevator, suspended from a cantilever arm of a traveller that can be moved alongside the car and unload it, delivering the contents to a wagon inside the traveller. The catalog also illustrates belt conveyors and screens.

TURBINE AIR HOISTS

The Sullivan turbine air hoists manufactured by the Sullivan Machinery Co. are designed to meet the demands for small, compact, powerful, portable hoisting engines for use in mines, quarries, tunnels, yards and shops. They may be mounted on a cross bar or column, bolted to a timber, girder, wall or floor, used for handling drills, steel, timbers, pulling cars, hauling lumber or various odd jobs. They weigh 285 pounds, will accommodate 500 feet of 5/16-inch wire rope and have a capacity to lift 5,100

SULLIVAN TURBINAIR HOIST

pounds dead load 100 feet vertically per minute under 80 pounds air pressure.

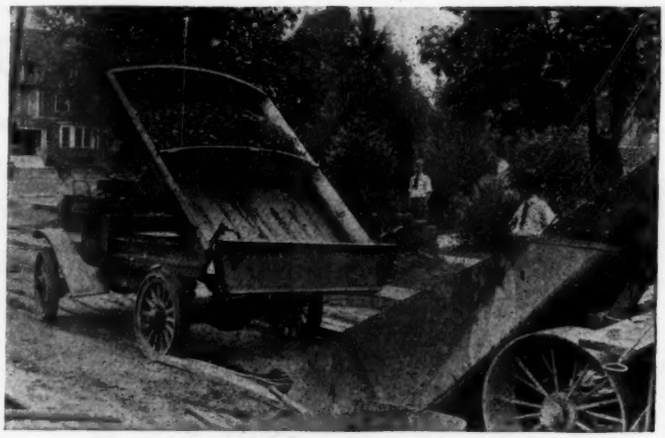
The turbine air motor and the remainder of the operating mechanism are completely enclosed in the steel drum and, using the air expansively are economical for power and have long life and sustained sufficiency. Some of the turbines have been in use for 5 years without requiring repairs.

It has friction clutch and brakes and when the former is locked in position the load can be raised, lowered and controlled entirely by the use of the throttle valve. It is rated at 4½ h. p., has dimensions of 32½ x 50¾ inches overall, and the drum is 9½ inches in diameter and 9½ inches long.

AUTOCAR MOTOR TRUCKS

The Autocar motor trucks, manufactured by the Autocar Company, are made with low sides, rotary dump equipment and bodies having 1, 1½, 2 and 3-yard water level capacities with platform bodies fitted with rocker bottom 1-yard Lee end dump dual hopper equipment.

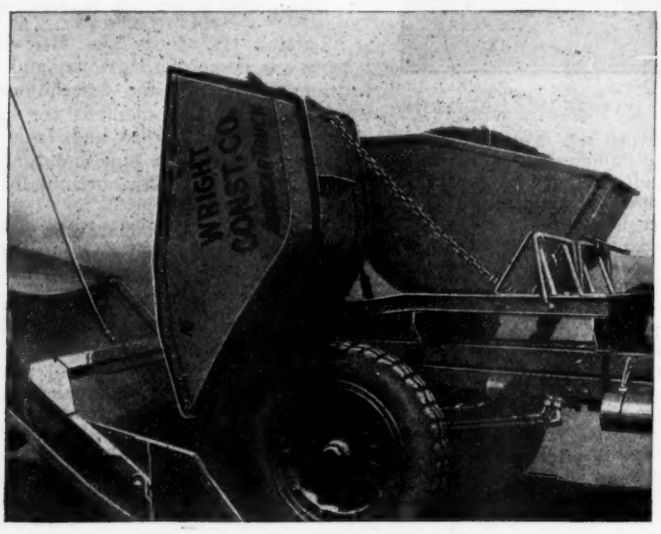
In building the 5-mile route 225 on the Pennsylvania State Highway between the Baltimore Pike and the Westchester Pipe, Delaware county, dry aggregate was hauled a maximum distance of 6½ miles with 2½-ton loads daily at a cost of $.30 per ton mile. The 20 trucks installed by the hauling contractor had rotary dump bodies with a special division board across the center, enabling them to carry two batches at once. They were loaded by gravity from overhead bins in two minutes and having a wheel base of only 97 inches, were easily turned on the concrete roadway only 18 feet wide before they were backed to the hopper of concrete mixer and unloaded in about two minutes. Twenty trucks were used on the long haul and produced an estimated saving of 16 men at $6 per day, equivalent to eight or ten cents per square yard of the concrete laid.



AUTOCAR ON ROUTE 225 PENNSYLVANIA STATE HIGHWAY

In the construction of 12 miles of the Jefferson Highway at Des Moines, Ia., six Autocars with Lee bodies hauled the dry mixture 5½ miles from the railroad siding to the concrete machine, making the round trip in 40 minutes and together handling 180 tons of materials daily.

In the construction of Route No. 127, Section No. 3, of the Baltimore-York Pike, Pennsylvania, Autocars equipped with platform bodies and oversize pneumatic tires, each hauled two steel batch buckets of dry mix from 3 to 4 miles to the concrete machine and dumped by hand into the loading skip of the mixer. An average of 10 trucks served the mixer, laying 350 to 500 feet of 18-foot concrete highway daily.



AUTOCAR ON JEFFERSON HIGHWAY

AUTOCAR ON JEFFERSON HIGHWAY

PERSONALS

Hoffman, Alexander G., has been appointed county road engineer of Ohio county, W. Va.

Rodenberg, E. R., has been appointed chief engineer of the East Side Levee and Sanitary District, East St. Louis, Ill.

Brooks, Clarence M., has been appointed deputy commissioner of highways for Vermont, and will be directly in charge of road maintenance work.

Smith, Burton, chief engineer of the Oakdale (Cal.) irrigation district, has resigned to become superintendent and chief engineer of the Merced irrigation district.

Givan, Albert, has been appointed city engineer of Sacramento, Cal., to take office when the new city manager plan goes into effect.